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EFFECTIVENESS OF INTERVENTION OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT SYSTEM ON IMPROVING SAFETY AND HEALTH AMONG THE LABORATORY TECHNICIAN/STAFF

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ABSTRACT

Managing and maintaining the physical emotional and cognitive well-being of the work force at any organization and their families caused due post an occupational injury is an extremely crucial process. Occupational health and safety management strategies to handle such needs while maintain confidence in the employees is adopted by most of the organizations around the world. The OHSMS system has been identified as a system that handles and maintains all kinds of occupational hazards that are introduced by the ILO. Most organizations worldwide has seamlessly incorporated this system in their managements. The effectiveness of such incorporations and other interventions pertaining to the management and maintenance of such systems is still not clearly understood and established. The current review aims to measure the effectiveness of interventional strategies with regards to occupational health management and the use of safety practices. This review employs a systematic search methodology to procure relevant literatures that highlight the functions of such systems. This review also establishes a link between the OHS managements systems and the service qualities provided by the hospitals. The current review recommends future research to be directed towards establishing and understanding a correlation between the prevalent occupational health and safety practice and the quality of the services provided.

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INTRODUCTION

International Labour Organization (ILO) has calculated the annual fatality rate as 2.2 million people falling victim to work related accidents and health issues while 270 million workers suffer non-fatal injuries. The report suggests that lack of efficient occupational safety causes considerable human and economic loss to the workforce, their families and the society. To avert such cost on the management's side and workforce's side Occupational safety and health culture is developed. Activities and practices involved in protecting the workers from work-related sickness, disease and injury is called as Occupational Safety and Health (OSH) management system (ILO, 2001). Occupational safety and health management system is adopted as a tool to direct organizations, institutions and at times even countries for handling the hazards and risks regarding safety and health issues which later turned out to be the system adopted as a benchmark for evaluating workplace hazards. Occupational safety and health culture has been popular among the organizations around the world for over three decades and a number of OSH practices have been developed over the years which many private, public and non-profitable organizations has adopted for their practice. As a matter of fact organizational health and safety management is not just about health and safety program. The Occupational Health and Safety Management Systems (OSHMS) are related with enhancement of Occupational Health System (OSH) conditions and also contribute towards the sustenance of safer and healthier workplaces among the individuals. Thus for development of a structured health and safer health management system to balance the work environment among the individuals (Mohammadfam, Ghasemi, Kalatpour, & Moghimbeigi, 2017). The OHS management system include health and safety policies, systems, standards, and records and correlates health and safety programs and activities into the employee's other business processes as well. Organizations can improve the identifying rate of industrial hazards with efficient OHS management systems and can control risks regarding occupational health. Components of OHS management systems include organizational leadership and commitment towards employee safety, a well maintained OHS procedures and instructions in written, training and instructions comprising health and safety, identification and managing hazards and risks respectively through proper inspection and investigation, organizing health and safety committees in the organization to bring the concerns of the workforce collectively, conducting occupational health and safety program according to the perceived concerns of the workforce (Alamgir, Cvitkovich, Yu, & Yassi, 2007). However, training and practice are important components of OHS program the instructions of the OHS program include hazard recognition and control, safer work practices, proper use of personal protective equipment, emergency procedures and preventive actions while the effectiveness of the of the OHS program is measured on the scales of knowledge, attitudes, beliefs, behaviour and health (Robson, *et al.,* 2007). Considering the basis of principle of decent work - safe work, safe work intends to create awareness on the dimensions and consequences of work related accidents, incidences and occupational diseases (KagoNjeru, 2015). Usually workforce expects the management to provide a safety and healthy working environment on behalf of both their welfare. Work related diseases sadly include challenges in training and practices of both occupational health and safety service system. The work related diseases are important not only from the occupational safety and health perspective but also in parallel to infecting general

population because working population around the world constitutes 50–70% of the adult population (KagoNjeru, 2015). Hence it is evident that challenges related to a health and safety in a particular organization also has an impact on general public health.

Laboratories are the places where a number of experiments are conducted and are inherently dangerous work environment where researchers test and prove their hypothesis through practical applications. The findings of an international laboratory survey undertaken in 2012 concluded that the safety culture in academic laboratories is not as well established as other work environments (Schroder, Huang, Ellis, Gibson, & Wayne, 2016). There are various types of laboratories include medical laboratories, pharmacokinetic laboratories, embedded laboratories, microwave laboratories, heat transfer laboratories and chemical laboratories. In order to obtain proper results without any incidents happening, attention must be paid to the safety and health issues in the laboratories, since lack of attention to health and safety can cause work related accidents like electrocution through high voltage, skin burn due to extreme heat, drawn into huge cooling fans and trauma caused by heavy objects falling and health issues including blurring eyesight, skin diseases and cancer (Langerman, 2009; Adane & Abeje, 2012; Gutie´rrez, Emery, Whitehead, & Felknor, 2013). The complexity of the implementing organizational health and safety management depends on the size of the institution, organization or workplace which in this scenario is laboratories and its current occupational safety and health performance and risk factors. For instance, a large laboratory will have more complex workplace risk factors than a small one because of the nature of experiments and activities that are undertaken in the laboratories. Though a lot of information is available about the importance of safety and health is available on laboratory management, staff members in laboratories cannot put control measures to prevent, control, or improve workplace environment and to control hazards. In certain instances some laboratory accidents may lead to fatalities due to the lack of cooperation between proper safety practices and usage of personal protective equipment which are significant and common among several other poor safety management issues. A positive correlation is perceived between intervention program and improvement of knowledge, attitude towards the practices of health and safety culture that enhances the ability of the workers in identifying hazards and fixes them on time (Ibrahim, El-Karmalawy, Hassan, & Hafez, 2017). Thus it is perceived that a laboratory with proper health and safety culture cultivates a safer work environment that aim at sustaining the health and well-being of the staff members of the laboratories (Ayi & Hon, 2018). Hence health and safety culture in laboratories is an essential global phenomenon that requires attention to avoid such lab injuries and fatalities.

Quality is a significant aspect of any successful organizations that is able to build a system to maintain and provide consistent quality products and services to expand the scope of customer satisfaction which leads to a hike in the organization's profits. Consistency in quality products and services is not possible unless it is supported, implemented, and correlated with occupational safety and health culture (Gaureanu, et al., 2016). The progress of an organization is based on the implementation of the instructions and practices related to quality, occupational safety and health and environment, the three pillars of a strong management through risk management and the phenomenon is defined by an integrated management approach (Zeng, Shi, & Lou, 2007). The implementation of

occupational safety and health management practices in laboratories determine the level of safety and health in the organization. Improper implementation of the safety practices in laboratories exposes the lab technicians and other related staff to various occupational hazards and risks in their work environment (Y.Chartier, 2014). General observation from previous studies under hazard exposure indicates that there are various types of hazards from various types of sources encountered in a laboratory. The hazards and risk factors involved in a work environment can impact the quality of service in a work environment. Thus the systematic on the effectiveness of the intervention programs in occupational safety and health practices and instructions in lab management draws emphasis on the impact of occupational safety and health practices in service quality of laboratories. To achieve the aforementioned aim of the review the following objectives should be completed:

- To evaluate the effectiveness of different OSH management systems interventions.
- To explore the role played by hospitals or laboratories in improving safety and health management among the technicians or staff members.
- To investigate the role of OSH management and their effect on quality of service in the laboratory.
- To explore the different intervention strategies OSH management system development in lab.
- To study the implications for the implementation of interventions of OSH.

METHODOLOGY

2.1 Primary Objective

The main objective of this review is to synthesize the available published literature on effectiveness of intervention occupational health and safety management on hospitals and laboratories.

2.2 Primary Outcomes

The outcome of interest in this review is to measure the effect of the different intervention strategies.

2.3 Types of Studies

Review articles, randomized controlled trials (RCTs), non-randomized controlled trials (NRCTs), controlled before-after studies (CBAs) and interrupted time series analysis (ITSs) were considered for this review.

2.4 Data Sources

The following databases were searched for potentially eligible studies: Pub med, Embase, Psyinfo, Eric and Google scholar. Updated searches of the electronic databases were performed in November, 2018 to ensure additional relevant papers were not published since.

2.5 Inclusion Criteria

This review included studies regarding interventions aimed at improving laboratory health and safety practices conducted in different countries which objectively measured the service quality (safer laboratory - safer work environment) served as the dependent variable.

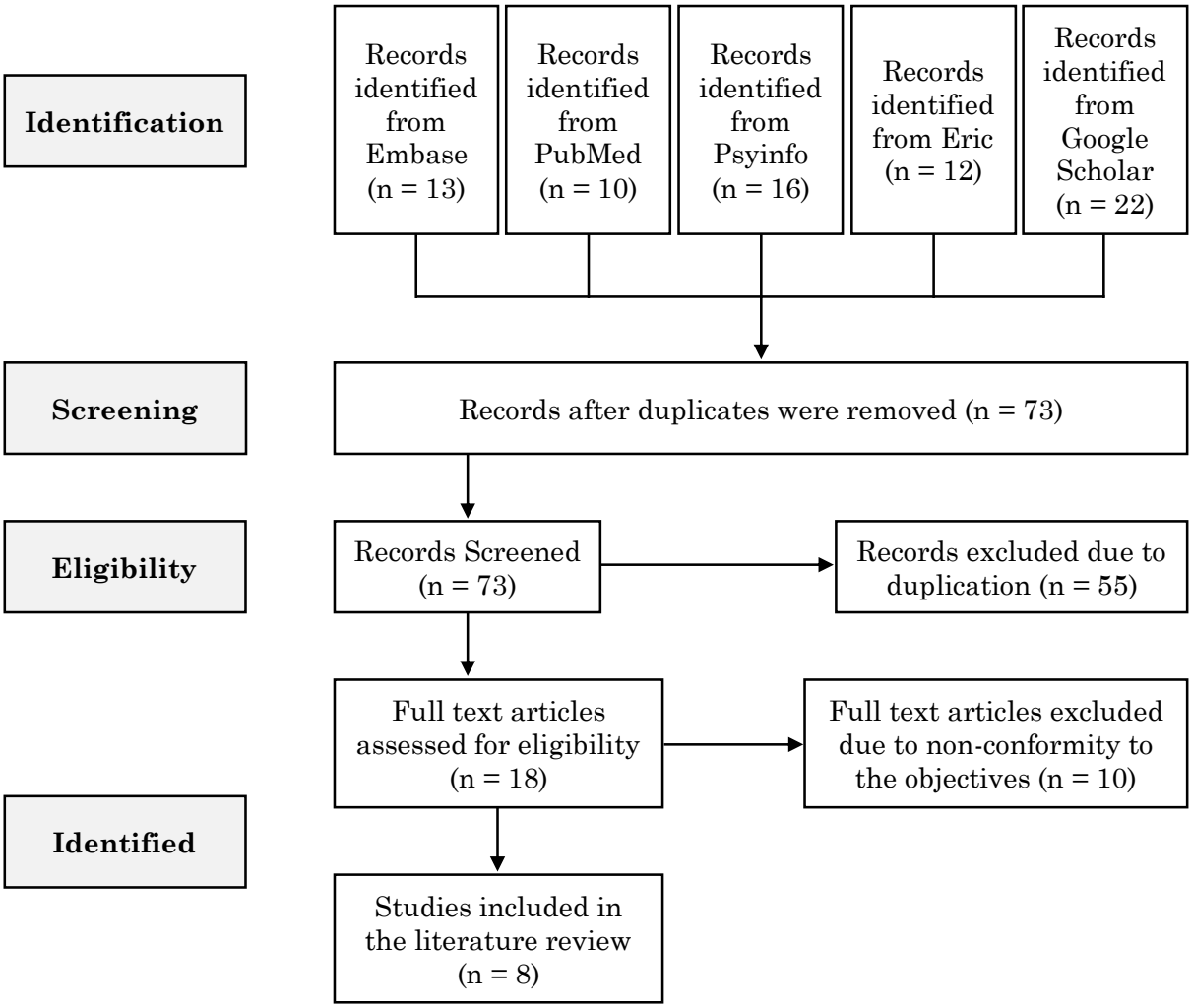
2.6 Exclusion Criteria

This review excludes studies related to intervention programs that are conducted in other sectors than laboratory safety which cannot be generalized.

2.7 Search Strategy

The studies selected for the review are selected by using occupational health and safety as the key search term and the intervention programs, laboratory and strategies from all fields in the databases Pub med, Embase, Eric, Psyinfo and Google scholar where several studies were found to be relevant to the individual terms of the inclusion criteria and from those only 8 studies were found to be having strong evidence of connection to the inclusion criteria.

Figure – 1: *PRISMA Flow Chart Format*



2.8 Keywords Used

Occupational health and safety and Laboratory

2.9 Data Collection and Analysis

The researcher has carried out the electronic database searches in five different databases for the collection of data. The data were collected from the citation of the prevailing literature. For each citation the reviewer has independently screened the titles and abstracts for potential relevance. The full text article was obtained for all potentially eligible studies. A reviewer has extracted data from the citations and checked the data extraction sheets for errors to make sure that the data is legitimate. Information was extracted on study design, year of study, setting, participants, intervention characteristics and the reporting of results. It was not deemed appropriate to conduct a meta-analysis due to the heterogeneity of interventions and outcomes across the included studies. Instead, the existing analyses reported in the articles reviewed were extracted and reported in a narrative PRISMA flow chart format *(see Figure – 1).*

2.10 Quality Assessment of Included Studies

The studies from the inclusion criteria were independently assessed for quality and risk of bias by the reviewer. This was performed using a modified version of the Cochrane Effective Practice and Organization of Care (EPOC) Data Collection Checklist is the methods/tools to extract data. The tool like Fuzzy Cognitive Mapping (FCM) is specifically designed for risk prioritization and interventions aiming to improve practice and provides a risk of bias assessment for each of the included study designs.

RESULTS

Author	Study design	Sampling and populations	Type of intervention	Result
(Almost, *et al.,* 2018)	quasi-experimental longitudinal research design	Semi structured interviews to Chief Executive Officer are organized and documents are reviewed. Survey is also conducted in the study. For the study all the employees are invited to participate.	Identification of the similarities between all the elements of occupational health and safety with six key leading indicators of an occupational health and safety hazards.	The indicators have a positive effect on a workplace health and safety culture.
(ITS, et al., 2017)	Quantitative study	918 workers and 30 factories participated in the population of the study. Two control groups	Using generalized estimation equation	The rate of accidental injury is observed to be lower at the rate of 89.3 to 52.1 per 1000 workers

		received traditional didactic training, including 907 workers from the same 30 factories and 1654 workers in matched control factories		after the intervention. And occupational health and safety training helps in reducing accidental work injuries and re-injuries among frontline workers.
(Ghahramani & Summala, 2015)	Empirical Quantitative study	The study was carried out in six companies. Three OHSAS 18001-certified, and three non-certified, include 998 occupational injuries for 15,842 person-months.	Before and after analysis using ANOVA	Influence in positive safety performance. The results of this study indicated that the implementation of OHSAS 18001 is not a guarantee of improved safety.
(Bas, 2018)	Quantitative and Qualitative study		The identification of OSH management hazards and risk factors, quantifying and polarizing of the OSH management risk and the hierarchy of the preventive measures that is to eliminate, control or minimize risk.	
(Herrera-Sánchez, León-Pérez, & León-Rubio, 2017)			Analyze the hazard and resources, promote team building and empowerment, establishing organizational infrastructure and undertake initial implementation	This study concludes that the intervention is a process cycle that includes follow up so it initiated a new cycle which identified new problems and will serve as the basis for designing new

			and further develop it by promoting innovation and achieve sustainability on an organizational level	intervention strategies or adaptations.
(Schroder, Huang, Ellis, Gibson, & Wayne, 2016)			Deriving the impact of regulations and policies on Lab Safety, calculating the impact on compliance and safety and calculating the impact of beliefs and attitudes towards Safety.	
(Fu, Zhu, Yu, & He, 2013)			Introducing the workers to laws and regulations of occupational health, rights and duties of the participants, educating the workers on safety of machine operation, safer distance and installation of guards and protective gear, informing the workforce about identifying and recognizing work hazards and control risk	A change in the employee practices towards occupational safety is observed
(Liu, et al., 2012)			Tests were performed at Calgary laboratory services. Administrative intervention to reduce the overall	The intervention undertaken will be cost-effective and taken less time by the practitioners and also provided an educational

			utilization and cost of referred-out chemistry testing.	opportunity for healthcare professionals.

DISCUSSION

4.1 Review of Literature

4.1.1 Evaluation of the Effectiveness of Different OSH Management Systems Interventions

Since OSH management is important for an organization it has gained importance over in every sector for three decades and several methods have been developed through literature to develop the OHS management and make it more efficient. With the intention to save lives by reducing hazards and their possible consequences through effective workplace health and safety programs many studies were conducted. They also have positive effects on both the behavior and productivity of workers which will be explored here. From the review of literature three studies were found related to the area. There is a great deal of focus made on occupational health and safety system on compliance (Avey, Reichard, Luthans, & Mhatre, 2011). Previous studies have indicated that the major factor that brings about a change is the incorporation of a culture that demands a healthy and safe place of work (Linzer, et al., 2017). Three studies found in the literature come inside the inclusion criteria which are presented in table 1. The first study in the table by (Almost, et al., 2018). That stands contrast to lagging indicators. The researchers have identified that a leading indicator is associated with proactive activities and consists of selected Occupational health and safety management system programs. Intervention programs conducted in the study is in two phases while the first phases will development of an intervention design while the second phase will evaluate the effectiveness of intervention strategies. The study suggests that there are many similarities between all the elements of occupational health and safety management system and there is no agreement on which of these elements is most beneficial to workplace health and safety. The study concluded that that are six key leading indicators of an occupational health and safety management systems which can have a positive effect on a workplace health and safety culture.

The second study by (ITS, et al., 2017) is conducted in china in the aim to study the effectiveness of an occupational health and safety training program. It is reported that the data for the research is collected from a control and experimental group of 918 participants each from different places and the effectiveness is compared before and after the intervention program and between the control and experimental groups as well. The research uses generalized estimating equations to generalize the findings of the study. The results of the study suggest that the rate of accidental injury is observed to be lower at the rate of 89.3 to 52.1 per 1000 workers after the intervention program. Hence the study concluded the evaluation of effectiveness of a participatory approach to occupational health and safety training in reducing accidental work injuries.

The third study by (Ghahramani & Summala, 2015) is conducted in Iraq. Many studies were conducted in this area following the growing interest in occupational health and safety program. However, Ghahramani and Summala present an empirical study on

the effect of occupational health and safety assessment series. The study collected from six different organizations in Iraq with three OHSAS 18001-certified, and three non-certified organizations. This study also used a pre and post analysis to analyze the collected data. The results show a positive safety performance change in one out of the three certified companies.

4.1.2 Role Played by Hospitals or Laboratories in Improving Safety and Health Management among the Technicians or Staff

In spite of the researches done on occupational health and safety management to create awareness on the subject that can be beneficiary to the staff members of the hospital and laboratories' contribution is an important aspect to raise awareness on the subject. Hence the review presents two studies that are found in the literature that matches the review. Previous study by (Ali, Shaalan, Al-Dahhan, & Yousif, 2016) is conducted in Iraq that explicitly reports about the incidents of laboratory accidents in Iraq to raise awareness on occupational safety and health practices in laboratories. The study uses the injury of a postgraduate student during a laboratory accident as a base to draw attention on how a specific combo of failures and deficiencies at different levels in an organization leads to a potential danger and serious laboratory accident by explaining what has happened in the explosion of biological safety cabinet and how to decrease the injury rate in a laboratory. The study not only identifies the root cause of the explosion but also brings to the limelight some safety practices in lab operations. The study suggests that if the OSHE principles are followed in a laboratory, it is most likely to identify the occupational hazard and control the risk including physical hazards associated with chemicals. The study concludes that the damage caused by the laboratory explosion was severe but can be avoided most likely with proper occupational safety measures and practices. The study emphasizes that through properly informing the staff members about the occupational hazards and preparation of list of potential hazards and practices the laboratory accidents can be avoided.

Another study by (Rugani & Dickson, 2014) is retrieved from a news article from the National academies based on USA that says that all the employee in a research laboratory play a significant in the establishment and promotion of a strong, positive safety culture. This requires a constant commitment to safety from the whole of the organization and significance on identifying and solving problems, rather than merely adhering to a set of rules and assigning blame when something is not going by the rules. Occupational hazards is found in many academic fields and settings, including the biological sciences, medical schools, engineering disciplines, and art studios. The study presents some recent serious and fatal accidents in research laboratories at U.S.

The findings of the study suggest that though intervention training is an important element of a positive safety culture, there is a lack of comprehensive, ongoing, and laboratory-centric training and education for various groups within the research community.

As per the literature provided by (Ferdohleb & Alina, 2017), it was explored that field training of the human resources and therefore producing professionals was considered as the key condition for ensuring quality and performance and also additionally it was World Health Organization (WHO) has developed different occupational health services models depending on the health systems. Further, the basic occupational health service

systems (BOHS) were considered to be significant to secure the health of the general community at different workplaces, their wealth and work capabilities and also to prevent occupational hazards that occurred at workplaces. For the common individual it has to be approachable, cost-effective and also the public authorities must guarantee it. The primary policy of WHO was to shape the global public health policy with the launch of "Health for All" strategy in the year 1977. It was the strategy undertaken by the WHO to provide the level of health to the community people of all countries by the year 2000 that would allow them to lead a productive life both socially and economically.

4.1.3 Role of OSH Management and their Service Quality Improvement

Quality is an important phenomenon of any potential outcome of an organization.

This section of the review will explore that literature that will provide an insight to the contribution made by the occupational safety and health management systems in playing a role in service quality improvement. From the review of literature one study has been found related to the area. The study conducted by (Allen, 2013) in Canada which describes how the implementation of a quality management system in an organization enhances the safety climate in a hospital. The research presents a thorough search that showed the factors affecting safety culture in hospital. The research concludes that to prevent patient safety issues due to the lack of the safety culture. Thus it is evident that the relationship between OSH management and service quality improvement is positive.

4.1.4 Different Intervention Strategies to Develop OSH Management System

From the review of literature it is evident that occupational health and safety in an organization can be improved by some intervention strategies. There are five studies found in the literature to be related to the research area. The study conducted by (Bas, 2018) proposes that there is a lack of connection between the Occupational Safety and Health (OSH) risks for the surgical team and the risks for the patient safety. This research uses the integrated approach of OSH risk management methodology. However, protective measures can be put into effect for eliminating, controlling or minimizing the OSH risks for a safer work environment for both the surgical team and the patient. The methodology proposed in the study is not only limited to the surgical environments or the healthcare industry which in this context can be generalized by using it in laboratories and hospitals as well. The intervention program consists of three sections with the first section being the identification of OSH management hazards and risk factors, The second section consist of quantification and polarization of the OSH management risk and the third section consist of the hierarchy of the preventive measures that is eliminate, control or minimize risk and use of personal protective equipment.

Another study performed by (Schroder, Huang, Ellis, Gibson, & Wayne, 2016) is a workshop session conducted on the intention to develop and improve the lab safety culture with lab safety regulations. The summation of the workshop derived three methodologies for implementing safety practices. The first is deriving the impact of regulations and policies on Lab Safety. The second is termed as 'Carrots versus Sticks' that calculates the impact on compliance and safety and the third one is calculating the impact of beliefs and attitudes on Safety.

A study by (Fu, Zhu, Yu, & He, 2013) is conducted in china among 525 welding workers. Baseline data such as working environment conditions and health condition of the workforce, worksite hazards and workers' behavior. Questionnaires were prepared that collected data on the knowledge, attitude, and practice of the occupational health. The participants gave score for each question on a scale of one to 10 according to their level of agreement. The occupational hazards included human factor engineering, warning signs, workplace cleanliness, and protective gear and health facilities. Participatory training courses consist of a series of programs that includes introducing the workers to laws and regulations of occupational health, rights and duties of the participants, educating the workers on safety of machine operation, safer distance and installation of guards and protective gear, informing the workforce about recognition of work hazards and risk control and ergonomic problems.

As per the literature provided by (Liu et al., 2012) it was observed that a simple intervention in the administration was successful in decreasing the quantity and cost of the referred out tests and also required lesser time for assessment from the pathologists who handle such cases. Further, development of intervention was a success as it induced further a sense of scrutiny by the ordering physicians.

4.1.5 Implications for the Implementation of OSH Related Interventions

This section will discuss the consequences that resulted due to implementation of the occupational safety and health management. It will further explore the factors like insufficient resources, lack of training, failure to carry out medical examination etc. that will influence the implementation of OSH management systems will be provided. From the review of literature three studies were found in the inclusion criteria for the required topic that is listed in the table 1. Previous studies by (Micheli, Cagno, & Calabrese, 2018) conducted in Italy dealt with Occupational Safety and Health interventions and its outcomes. Some intervention is proven to be effective only under controlled conditions. The study divides the intervention process into three phases namely design, implementation and control. The study is conducted to understand what if under circumstances OSH intervention works or does not. The research was designed following multiple case study research, which enables an in depth understanding of the intervention process and the identification of the most relevant factors for OSH. The data were analyzed through an analytical research framework that enabled the identification of the main mechanisms and contextual factors for the interventions that had an expected outcome and for those which had an unexpected outcome.

The study by (Gilson, Straker, & Parry, 2012) is conducted in Australia dealt with the perception of OHS practitioners and who is concerned about the workplace health issue like occupational sitting. The study explored diverse ideas for strategies the dichotomy between providing choices for employees to resolve health issues related to occupational sitting that includes change in the job environment and office design like centralizing printers and scanners. Productivity concerns were found to be a major influence for change. The study highlighted the value of using cross-disciplinary expertise to bridge the gap between research and practice. And the study concluded that OHS practitioners in Australia have a good understanding of the risks of prolonged occupational sitting and potential strategies to manage these risks.

In general, the public are not concerned with occupational safety and health at present. Subjects with different identities also paid little attention to occupational safety and health. Employees in third-party social institutions gave the most attention to occupational safety and health, and they cared the most about occupational diseases, whereas the staff in mines showed the minimum level of attention to occupational safety and health.

Another study conducted by (Herrera-Sánchez, León-Pérez, & León-Rubio, 2017) is conducted in Spain which focuses on the implementation process of the intervention program and attempts to move this field forward by identifying the main factors that contribute toward ensuring a greater success of occupational health and safety programs. The steps include analyze the hazard and resources, promote team building and empowerment, establishing organizational infrastructure and undertake initial implementation and further develop it by promoting innovation and achieve sustainability on an organizational level. The study concludes that the intervention is a process cycle that includes follow up so it initiated a new cycle which identified new problems and will serve as the basis for designing new intervention strategies or adaptations.

RESEARCH GAP

Despite the growing popularity of the occupational health and management system in recent years and the increasing focus on OHS management very few studies were found to be relating OHS management to service quality. There are studies presenting different intervention strategies to develop occupational safety and health and a number of studies were found evaluating effectiveness of the intervention programs. The studies that can be generalized under laboratory safety is selected in this review where very few literature is found to present the correlation between OHS management and lab safety and health management.

CONCLUSION AND RECOMMENDATIONS

From a detailed discussion on table 1 it is evident that the intervention programs are reported to be effective on the occupational health and safety but the agreeableness to the effects is observed to be on different levels from different studies. Some studies are conducted in different countries under different sectors like textile, welding, health care and others but the findings of the selected studies can be generalized under laboratory safety and from the review it is observed that there is only little initiative taken in the side of the hospitals and laboratories to create awareness on lab safety and health issues.

RECOMMENDATIONS

For future and further studies in this area it is recommended to conduct more studies involving hospitals and laboratories taking initiative in creating awareness on the OHS management among lab technicians and related staff.

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